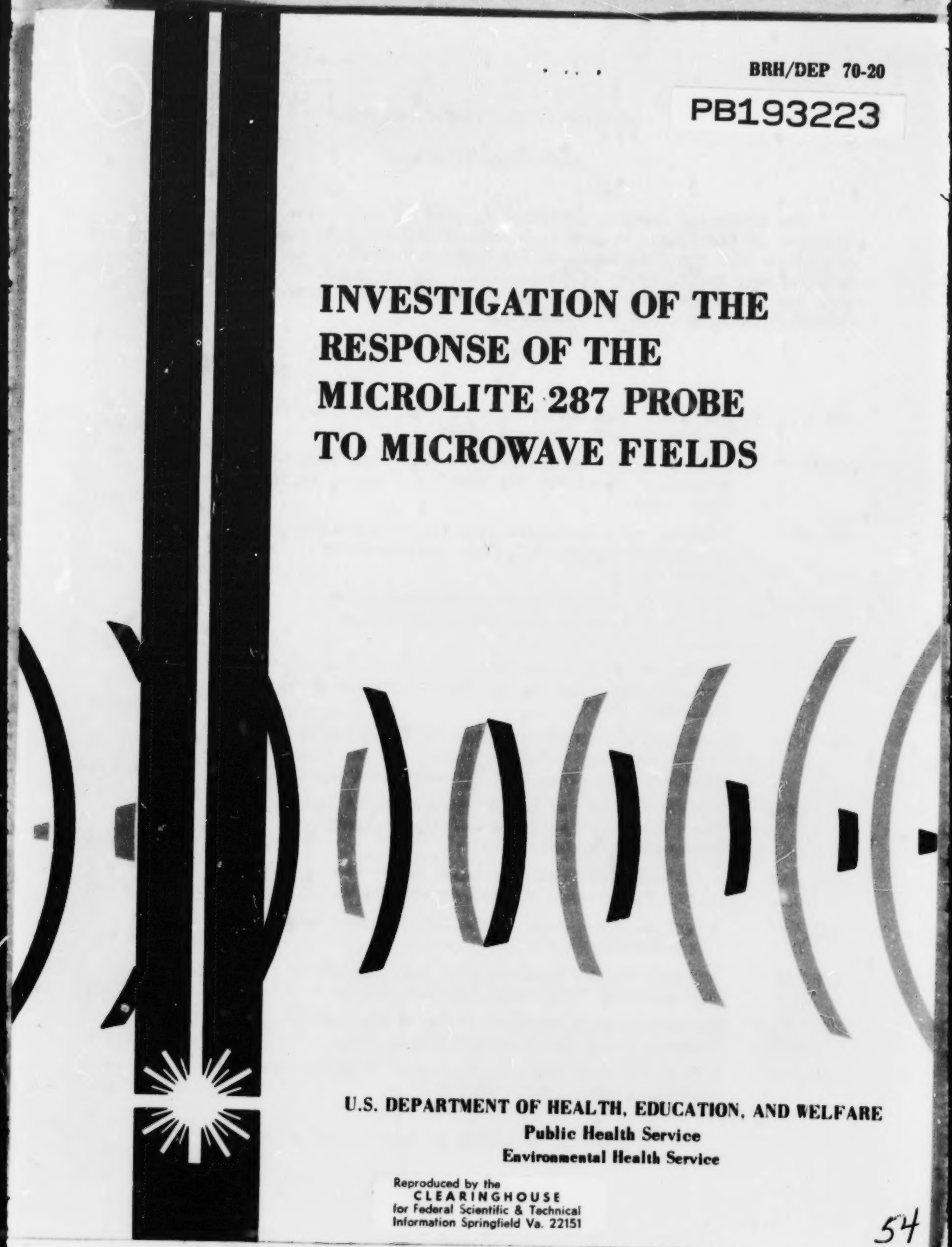
BRH/DEP 70-20

PB193223

INVESTIGATION OF THE RESPONSE OF THE MICROLITE 287 PROBE TO MICROWAVE FIELDS



U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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(continued on inside of back cover)

BRH/DEP 70-20

INVESTIGATION OF THE RESPONSE OF THE MICROLITE 287 PROBE TO MICROWAVE FIELDS

Herbert F. Kein, Mays L. Swicord, David G. Brown

Radiation Measurements and Calibration Branch

and

Robert L. Moore

Product Testing and Evaluation Branch

Division of Electronic Products

August 1970

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Environmental Health Service
Bureau of Radiological Health
Rockville, Maryland 20852

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FOREWORD

The Bureau of Radiological Health, formerly the National Center for Radiological Health, continues to carry out a national program designed to reduce the exposure of man to hazardous ionizing and nonionizing radiation.

Within the Bureau, the Division of Electronic Products (1) develops and administers performance standards for radiation emissions from electronic products; (2) studies and evaluates emissions of and conditions of exposure to electronic product radiation and intense magnetic fields; (3) conducts or supports research, training, development and inspections to control and minimize such hazards, and (4) tests and evaluates the effectiveness of procedures and techniques for minimizing such exposures.

The Bureau publishes its findings in Radiological Health Data and Reports (a monthly publication), Public Health Service numbered reports, appropriate scientific journals, and technical report series for the Bureau's divisions, offices, and laboratories.

The technical reports of the Division of Electronic Products (DEP) allow comprehensive and rapid publishing of the results of intramural and contractor projects. The reports are distributed to State and local radiological health program personnel, Bureau technical staff, Bureau advisory committee members, university radiation safety officers, libraries and information services, industry, hospitals, laboratories, schools, the press, and other interested individuals. These reports are also included in the collections of the Library of Congress and the Clearinghouse for Federal Scientific and Technical Information.

I encourage the readers of these reports to inform the Bureau of any omissions or errors. Your additional comments or requests for further information are also solicited.

John C. Villforth
Director
Bureau of Radiological Health

PREFACE

The Division of Electronic Products, Bureau of Radiological Health, as part of its responsibility under the Radiation Control for Health and Safety Act of 1968, PL 90-602, conducts a program of evaluation of the effectiveness of procedures and techniques for minimizing exposure to radiation from electronic products. This report presents information and performance data on a low-cost device proposed for use in determining microwave oven leakage.

Robert L. Elder, Sc. D.
Director
Division of Electronic Products

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ABSTRACT

THE
~~This~~ report describes tests performed on the Microlite 287 microwave oven leakage probe under laboratory and field simulated conditions. The probe contains a preignited mercury-neon gas which ionizes and glows in the presence of radiofrequency energy. The probe-to-probe variability and the difficulty encountered in observing the change in glow intensity seriously limit the usefulness of the probe as a measurement device. It may be useful as a device for detecting gross microwave oven leakage.

INVESTIGATION OF THE RESPONSE OF THE MICROLITE 287 PROBE TO MICROWAVE FIELDS

INTRODUCTION

The International Crystal Manufacturing Company, Inc., is proposing to distribute a new device, the Microlite 287, to customers for surveys of their microwave ovens. According to International Crystal, (see literature in appendix A) the "Microlite 287 is a preignited lamp for testing power leakage of microwave ovens operating in the 2450-MHz range."

This device consists of an Amperex 4662 neon-mercury glow tube and a suitable power supply for ionizing the tube gases, all mounted in a plastic cylindrical probe 34 cm in length and operated from 115 volts a. c. The probe assembly is described in detail by the tube manufacturer (Amperex) in appendix B. A plastic foam spacer is placed over the tube to provide alignment and ensure a 5-cm space in use. Two ports and one indicating mark, designated levels 1, 2, and 3 respectively, are integral to the probe to provide a means of determining approximate power density levels. Level 1 determination is obvious at very low power densities (less than 0.5 mW/cm) as the orange preignition of the tube becomes slightly blue colored with ionized mercury vapor. However, it is difficult to determine when level 2 is reached because of the glow reflected by the glass tube wall from level 1 indications. The presence of level 3 glow is readily determined as the blue glow "jumps" to the tube tip.

Appendix A includes information the vendor provides to customers with the probe. This information includes a detailed test procedure with photographs of probe positioning. The instructions do not clearly state that a flash caused by stirrer or door opening action is a reportable measurement.

Two letters to the Director, Bureau of Radiological Health, dated January 21, 1970, and January 23, 1970, are reproduced in appendix C. The manufacturer states that the plastic foam spacer will be cemented onto the tube. These letters also indicate the vendor will test at 11 mW/cm^2 to determine if Microlite tip (level 3) ignites. If a tube fails to indicate level 3 in this field, the tube will be rejected.

Three Microlite 287 probes, designated 1, 2, and 3, were supplied by the manufacturer to the Bureau of Radiological Health for testing. It was not specified whether these were calibrated (certified) probes which the manufacturer states are available at extra cost.

MICROLITE TESTS

DETECTION OF LEAKAGE FROM MC-24 OVEN

Three Microlite 287 probes were used to determine leakage from an International Crystal Manufacturing Co., Inc., MC-24 oven whose leakage had been increased by placing tape between oven door and door jamb. The survey procedure suggested by the vendor in his instructions (appendix A) was followed.

In two of the three probes, level 2 and level 3 glow corresponded to 4 and 10 mW/cm^2 respectively as measured with a Narda 8100 in its fast response position. Precise onset of blue glow for level 2 or 3 was difficult to determine because of fluctuations in power levels caused by stirrer action. In a test of a third probe, level 2 and level 3 corresponded to approximately 8 and 15 mW/cm^2 respectively.

The flashes on the Microlite caused by power density and polarization changes due to stirrer action were not "tracked" by the reference measuring instrument (Narda 8100), probably because of differences in response times. The comparison therefore is subject to an undetermined error associated with the differences between the glow level and the associated power density determination.

The Microlite was found to be nonisotropic. Thus, the probe will indicate less than actual leakage unless held in the most favorable orientation.

At low power levels, high ambient lighting made determination of the glow level of the tube difficult. Use of the probe should be specified under an approximate ambient light level for reproducibility.

EFFECT OF PROLONGED 100 mW/cm^2 EXPOSURE ON THE SENSITIVITY OF THE MICROLITE DETECTOR

Using a Cober Electronic Corp. Model MP 2.5, 2.5kW 2450-MHz (output modulated at 120 Hz) microwave source in an anechoic chamber, four Microlite probes were exposed to power densities that indicated levels 1, 2, and 3 on the probe. Probe number 4 had been supplied to the Bureau of Radiological Health through a direct mailing by the oven manufacturer to the "registered microwave owner." It is believed that this probe is representative of Microlites sent to individual oven owners throughout the country by a similar mailing procedure.

Actual power densities were determined by recording forward and reverse power from a power meter and relating these power levels to power densitieis measured with a Narda Model 8100 (with Model 8122 probe) power density meter.

Table 1 below shows power densities at which level 1, 2, and 3 indications were seen by a radiation physicist. To verify the readings, a second observer made level determinations as shown in table 1.

Table 1. Microlite probe glow level as a function of power density before irradiation to 100 mW/cm^2 for 30 minutes.

Microlite Probe	Power density initiating glow level (mW/cm^2)		
	1	2	3
Number 1	< 0.5	32	32
Number 2	< 0.5	14	32
Number 3 (Observer 1)	< 0.5	16	30
Number 3 (Observer 2)	< 0.5	23	31
Number 4	< 0.5	16	>37

After initial determination of the glow level as a function of power density for each of the four probes, probes 1 through 3 were exposed to 100 mW/cm^2 for 30 minutes. Each probe was operated during the exposure period. Probe number 4 was maintained as a nonirradiated control. Seventeen hours after this exposure, the determination of the glow level as a function of power density was repeated for each probe under conditions identical to the pre-irradiation determination. Table 2 presents results of the post-irradiation determination described above.

Table 2. Microlite probe glow level as a function of power density 17 hours after microwave irradiation at 100 mW/cm^2 for 30 minutes.

Microlite Probe	Power density initiating glow level (mW/cm^2)		
	1	2	3
Number 1	< 0.5	31	31
Number 2	< 0.5	20	27
Number 3	< 0.5	20	23
Number 4	< 0.5	32	> 37

After irradiation some probes exhibited slightly higher senstivity for level 3 while showing lower sensitivity for level 2. However, the difficulty in deciding when level 2 glow was achieved introduced an ambiguity of up to 50 percent in the power densities associated with this level. The control probe (number 4) exhibited decreased sensitivity for level 2. No change was seen for level 3. The minimum power density which yielded a level 3 indication in this 120-Hz modulated field was 23 mW/cm^2, while the maximum was greater than 37 mW/cm^2.

Crapuchettes[1] reported, "the threshold level of breakdown (glow) of 2mW/cm^2 is predictable on new tubes but that the level very rapidly increases. In some cases, it has been found that they do not break down (glow) at the 100 mW/cm^2 level after only 5 hours of use."

"SIMULATED OVEN OWNER" USE OF MICROLITE PROBES

Three female clerical personnel were asked to "survey" a Model MC-24 oven according to the instructions to owners (appendix A) provided by International Crystal Manufacturing Co., Inc.; the door of the oven had been taped to create leakage. They were also asked to fill in the survey form provided with the instructions. No other information was provided to these surveyors who made independent determinations. Probe number 4 was used for this test. Experienced radiation physicists observing these three simulated owner surveys noted the following:

1. All three "surveyors" neglected to observe when the water load boiled. Observers reminded them to prevent this boiling.

2. Two of the three "surveyors" made "door burst" tests 5 to 10 seconds after the interlock had turned the oven off, first opening the door completely and then surveying for leakage.

3. None of the three "surveyors" observed the flashing of level 3 that was clearly obvious to the three physicists.

The following table summarizes the results obtained by the three surveyors. Category areas are those shown on the survey form provided by the manufacturer.

---

[1] CRAPUCHETTES, P. W., Microwave leakage --its nature and means for its measurement. Journal of Microwave Power 4(3):149 (1969).

Table 3. Operation survey of MC-24 oven by three simulated oven oven owners.

Area of Oven	Power Density Obtained Using Narda 8100 (mW/cm^2)	Microlite glow level seen by observer[a]		
		A	B	C
Top edge	4 to 8	1	2	2
Left edge	1	1	1	1
Bottom edge	< 1	1	none	1
Grill	< 1	1	none	1
Right edge	≤ 1	1	1	1
Cabinet	< 1	1	none	1
Door burst	1	none	none	1

[a] According to the manufacturer, level 1 = 1-3 mW/cm^2; level 2 = 3-7 mW/cm^2; and level 3 = 7 mW/cm^2 (appendix A). The simulated oven owners, therefore, did not detect an 8-mW/cm^2 leak as level 3.

The results of tests made on the four probes in the anechoic chamber (tables 1 and 2) indicated that the level 3 readings observed by qualified surveyors were caused by peak equivalent power density levels greater than 23 mW/cm^2.

TEST OF MICROLITE PROBE AT POWER DENSITY OF 12 mW/cm^2

The door of an MC-24 oven was taped open slightly to create leakage of 12 mW/cm^2 (determined by a Narda 8100/8122), and four Microlite 287 probes were individually placed in the microwave field and observed. Probes number 3 and 4 indicated level 3, while probes number 1 and 2 indicated level 2 only. The observer was a radiation physicist.

SUMMARY

The Microlite 287 probe is an inexpensive microwave-indicating device. With careful selection of tubes and calibration of each probe assembly, some indication of power densities from leaking microwave ovens can be achieved. The performance of the probe assembly was studied in an anechoic chamber and under "home user" simulated conditions. The power density measurements made with the Microlite on microwave ovens with associated stirrer action, and on 120-Hz modulated microwave fields in an anechoic chamber were substantially different from those made with a Narda 8100 under the same conditions.

CONCLUSIONS

The Microlite 287 was not found to be a satisfactory instrument for measuring microwave oven leakage. If carefully and regularly calibrated and carefully used, it can provide some information to its user, particularly in detecting grossly excessive levels of microwave power leakage from microwave ovens similar to those manufactured by the International Crystal Manufacturing Co., Inc. In the opinion of physicist observers, the only level at which the glow of the Microlite was clearly discernible was level 3 due to the "jump" of the glow to the tube tip. However, based on the tests described above, about half of the devices, unless specially selected, may not indicate as a level 3 reading the presence or absence of equivalent power densities of approximately 12 mW/cm^2. All indications from this device should be evaluated carefully.

The results of simulated-owner tests performed in our laboratories indicate that the validity of owner surveys using this instrument is questionable. The use of level 2 glow for "measurement" of microwave power densities associated with ovens is not recommended because of problems discussed above. This device does not eliminate the need for an oven survey using accurate, well-calibrated instrumentation.

APPENDIX A

INTERNATIONAL CRYSTAL MANUFACTURING COMPANY, INC., LITERATURE

INTERNATIONAL CRYSTAL MANUFACTURING CO., INC.
10 NORTH LEE • OKLAHOMA CITY, OKLAHOMA
TELEPHONE 405-236-3741 • TELEX 071-347 • TWX 910-831-3177 • CABLE INCRYSTAL

REFERENCE:

DEAR INTERNATIONAL CUSTOMER:

INTERNATIONAL, in cooperation with the Department of Health, Education, and Welfare, is conducting "Operation Survey" on all INTERNATIONAL Microwave Ovens in use, to locate any ovens not meeting safe specifications.

You may have read some of the news releases regarding the government survey, and although our investigation of INTERNATIONAL ovens within our local area did not reveal any "bad" ovens, it is our desire to contact all users to insure their oven has not developed a defect.

The energy used in microwave ovens to heat food will have the same effect on the human body if exposed at sufficient levels. In the past, a level of 10 milliwatts per square centimeter near the oven surface has been acceptable as it was considered powers of 100 milliwatts were required to cause damage. The heating in most parts of the body is reversible and will be dissipated by the blood flow. The most susceptible areas are the eyes since the blood vessels are very small and are not able to carry off the heat. The levels measured near the oven surface reduce rapidly with distance from the oven. It is INTERNATIONAL's intent that ovens measuring levels 5 MW/CM^2 or more two inches from the oven require adjustment, and ovens with 5 MW/CM^2 or less are safe for operation.

In order that you may check your oven for this survey, INTERNATIONAL is enclosing a simple test lamp and we ask that you follow the instructions and test the power leakage of your oven. Please note the results on the enclosed form and return to INTERNATIONAL in the envelope provided. Keep the test lamp for periodic checking of your oven and if you have a friend who has not had his oven checked, use your lamp to help insure his safety in operating his oven.

If during the testing of your oven you observe a level #3 glow, contact INTERNATIONAL at below address regarding corrective action.

International Crystal Mfg. Co., Inc.
10 North Lee
Oklahoma City, Oklahoma 73102
Attn: Operation Survey

CAUSES OF POWER LEAKAGE IN MICROWAVE OVENS

All microwave ovens are checked and adjusted for safe leakage levels before leaving the factory. Therefore when an oven developes power leaks beyond a safe limit, something has to change within the oven adjustment. The most likely area is the door seal. This seal type as been cycle tested the equivalent of 10 years operation with only a very small increase in power leakage. To increase the power leakage something abnormal must occur.

With a new oven, shipping damage is the most likely possibility of causing a change in the power leakage. Normal handling will not damage the seal, and usually the damage is obvious where the oven has been dropped.

During use a coating of grease or food particles on the door seal can provide sufficient gap in the fit of the seal to increase the power leakage. Merely keep the seal and the face of the oven cavity wiped clean with a damp cloth and no leakage should occur from this cause.

Mechanical abuse of the oven door can cause both the door seal and the latch to become misadjusted with the result of increased power leakage.

SPECIAL MEASUREMENT NOTES

Should the cup of water in the oven begin to boil during the measurement, stop and replace it with fresh cool water.

Do not mistake the reflection of level 1 and level 2 glows in the end of the lamp as level 3 glow. Level 3 glow will be easily seen around the metal electrode in the center of the lamp.

Glow levels will change with the rotation of the oven stirrer, and therefore may flash on and off.

Do not be alarmed if you are not able to observe a blue glow in any level as you are testing your oven. As long as the orange preignited electrode is seen thru the level 1 hole, the lamp is working properly. Normally new ovens will not cause the lamp to glow or at most a slight glow in level 1. With older ovens you may observe a glow in levels 1 and 2. Ovens causing a glow in level 3, should be operated with caution or not at all until corrective action is taken.

USING MICROLITE 287

Microlite 287 is preignited lamp designed for testing power leakage of microwave ovens operating in the 2450 MHZ range. The Microlite 287 is equipped with a plastic spacer and guide to place the lamp approximately two inches from the oven surface. Do not remove this spacer.

Three levels are indicated on the lamp spacer. When the lamp cord is connected to an 115VAC outlet you will observe the orange electrode glow through level hole #1. This is the normal operating condition of the lamp.

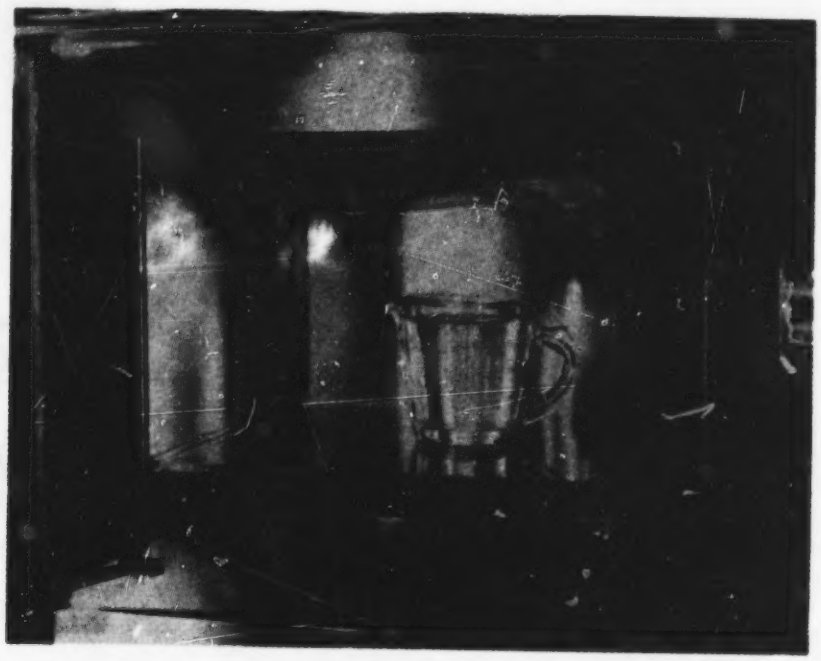
The three blue glow levels mentioned will be observed through hole #1, hole #2, and #3 beyond the spacer to the bulb tip. With energy levels of 1 to 3 MW/CM^2, a blue glow will be observed in level hole #1. With energy levels of 3 to 7 MW/CM^2, the blue glow will be observed through holes #1 and #2. The levels greater than 7 MC/CM^2 the lamp will glow blue beyond the spacer in the tip area.

Where a glow is observed in level #3, the tip area during the measurement, the oven should be operated with caution until service adjustment is obtained. Ovens that produce a level #3 glow only during the door opening test, should be operated so that the "cook" power is off before the door is opened. Corrective action should be taken at the earliest possible time.

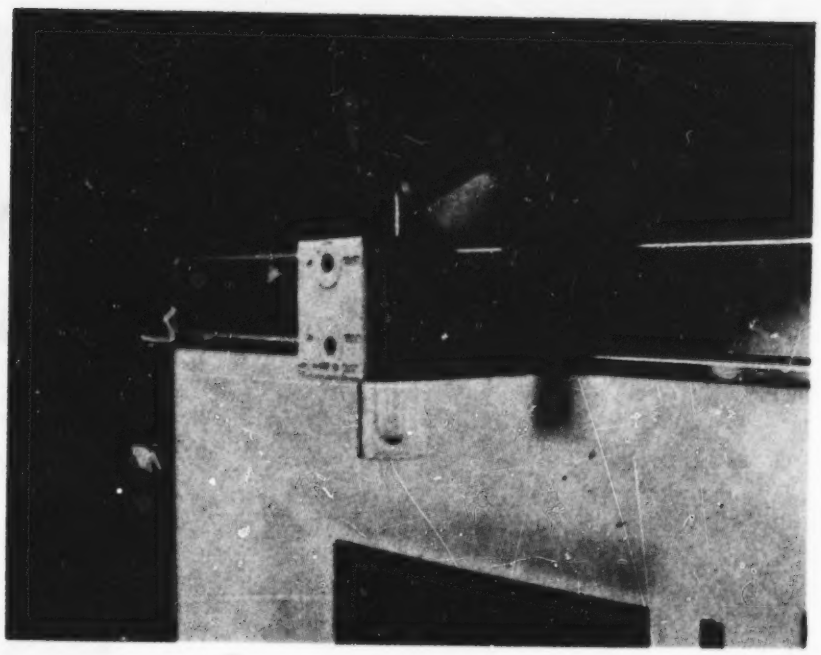
Test Procedure

(1) Place an 8 oz. measu[illegible]g cup filled with tap water in the oven at the center of the tray or shelf.
(2) Operate the oven and check the top edge of the door by moving the Microlite spacer edge along the crack between the door top and trim. The handle of the lamp will be perpendicular to the crack. When testing, the lamp will always be perpendicular to the opening being tested and two inches out as provided by the spacer. Carefully note the maximum blue glow level, observe and list on the report sheet. Check each of the four edges of the door and record the level observed.
(3) Move the edge of the lamp spacer back and forth across the grill area. Do this with the handle vertical and horizontal. Record results.
(4) Check the outside of the cabinet for any possible glows. Normally none will be found.
(5) The "door burst" or door interlock check is made to insure proper adjustment of the interlock system. With the Microlite positioned in the right door edge crack near the handle using the right hand, grasp the handle with the fingers of the left hand. Place the left thumb against the timer panel to provide leverage. Slowly pull the door open while observing the lamp. The oven should stop cooking before the level #3 glow is observed. Make this step at arms length and should a level #3 glow appear, immediately close the door and turn the cook power off before opening the door. Check the door burst level at several points around the edge.
(6) Record the results.

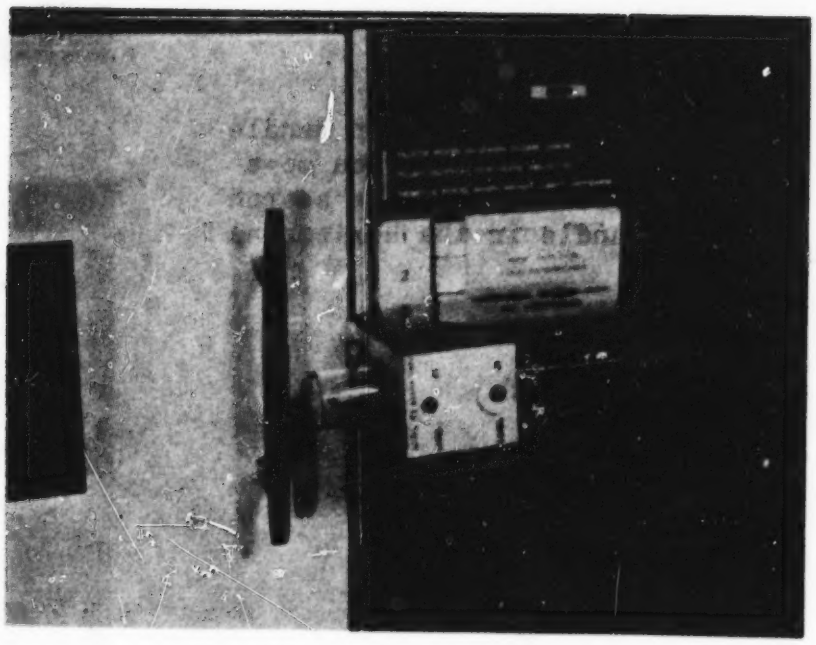
Place 8 oz cup of water in center of oven shelf.



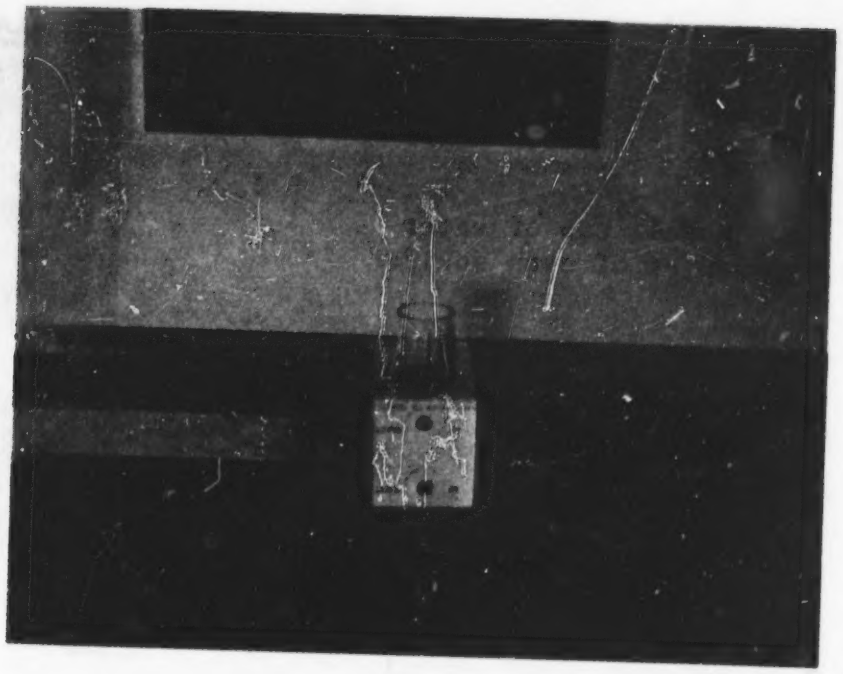
Plug Microlite 287 into wall outlet, and hold edge of spacer wedge along opening being checked. Move back and forth along top edge of door. Level #1 will be observed thru the top hole in photo. Level #2 will be seen thru the second hole, and level #3 is the tip of the lamp extending beyond the spacer.



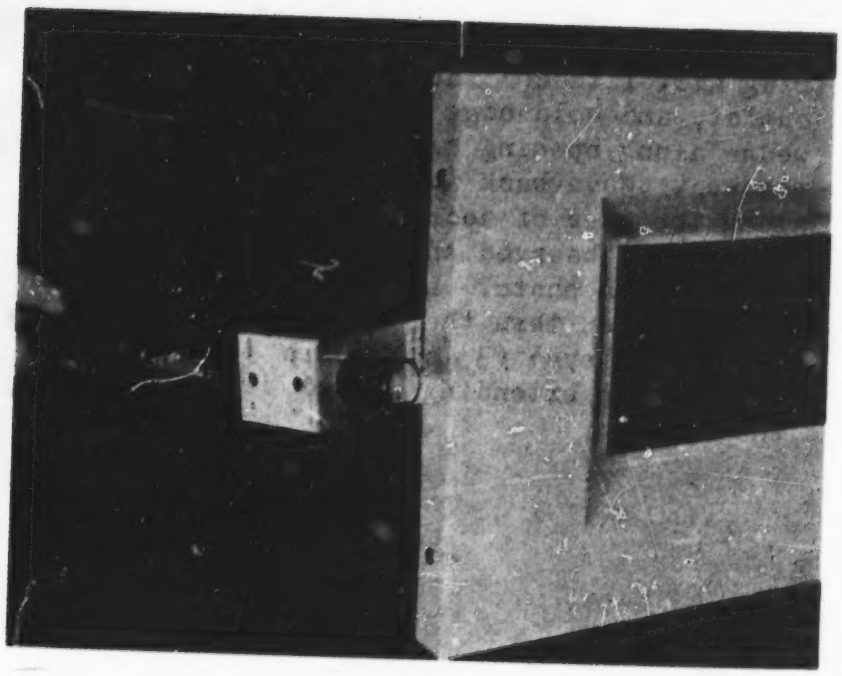
Check right edge of door in the same manner as the top edge. Move lamp back and forth with edge of wedge in door crack.



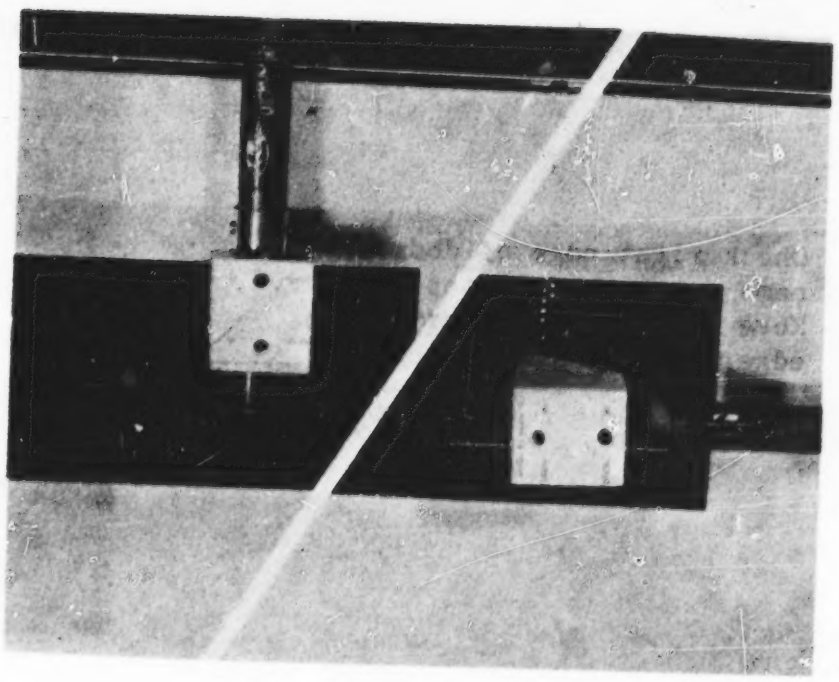
Check along bottom edge of door.



Check along left edge of door opening.

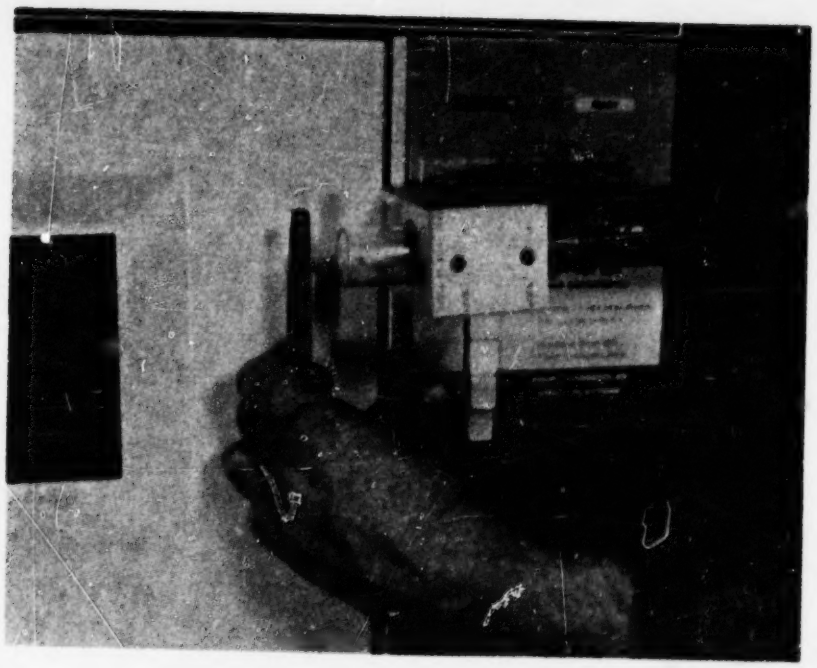


Check grill area with lamp handle in vertical position as you move over the area. Repeat the search with the handle in the horizontal area.



Probe along all cabinet openings.

Check for maximum power leakage as door is pulled open. Use leverage of thumb and fingers to slowly open door.



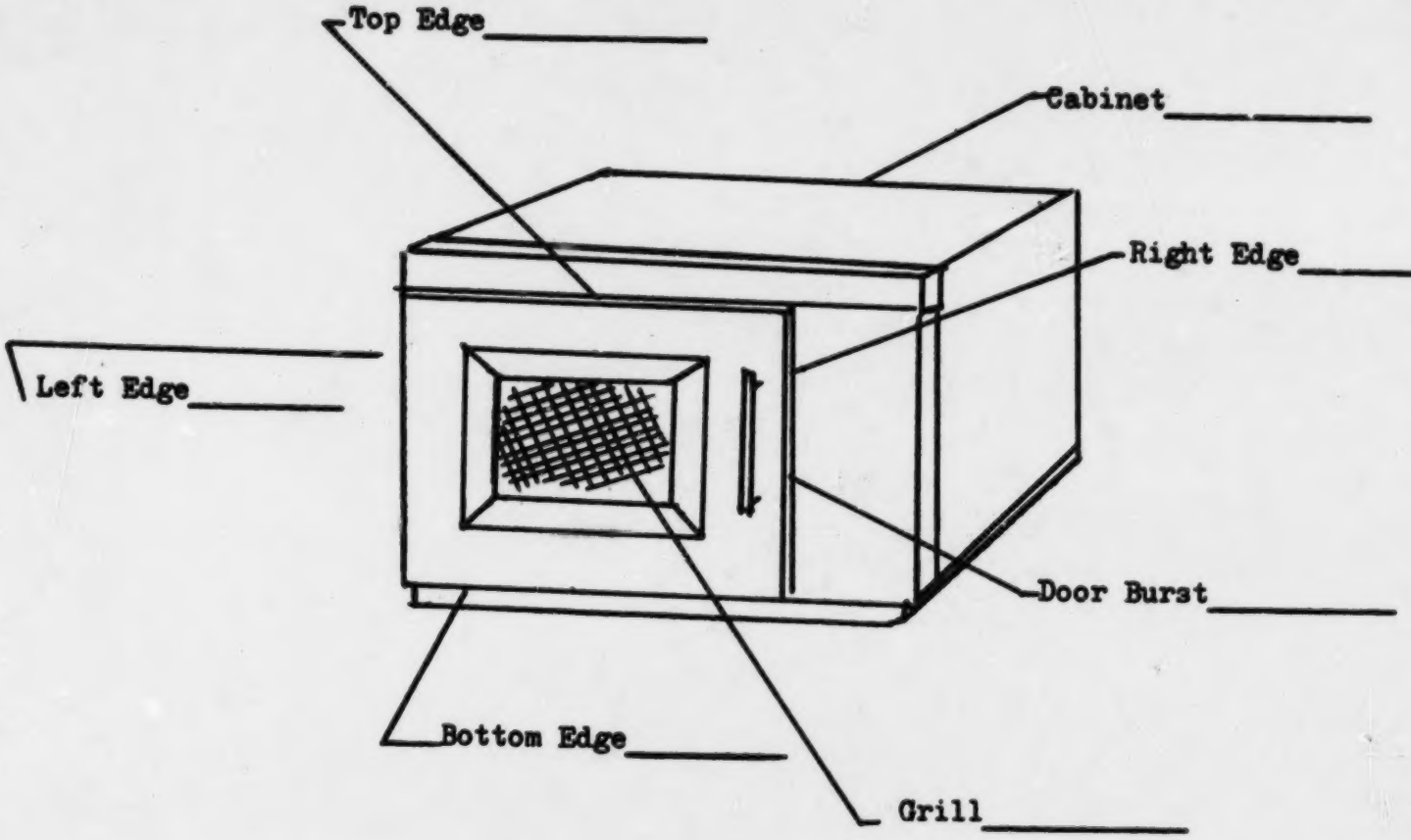
OPERATION SURVEY REPORT

Oven Type _____ Serial Number_____ Date_____

Device Used in Measurement_____

Measured By_____

Note: Use load in center of oven shelf, 8 oz or 275 ml of water. Measurements at a distance of 2 inches from oven surface.



APPENDIX B

AMPEREX APPLICATION REPORT

Amperex®
APPLICATION REPORT

ALR #1092

TWO METHODS FOR EVALUATING STRAY RF RADIATION AT 2450 MHz

Authors: R. Kaminsky
R. Rathmann

Approved: W. Hickman

Date: August, 1967

APS #61-22-200

Revised--September, 1967

POWER TUBES • MICROWAVE TUBES
NUCLEAR PRODUCTS

PROFESSIONAL TUBE DIVISION
AMPEREX ELECTRONIC CORPORATION

HICKSVILLE, LONG ISLAND, NEW YORK • 516/WEllis 1-6200

ALR #1092 August, 1967

SUMMARY

This report describes two circuits which are useful for evaluating the stray RF radiation in the immediate vicinity of microwave equipment.

While these circuits are rather unsophisticated, their value lies in the convenience and simplicity of construction and use.

ALR #1092 August, 1967

INTRODUCTION

In the design and evaluation of microwave heating equipment, the density of stray radiation from the equipment into the surrounding area is of great importance. The most commonly accepted value of radiation density below which no harmful effects have been experienced is 10 mw/cm^2.

This report describes two convenient methods for qualitatively measuring stray radiation near the 10 mw/cm^2 level.

The first method uses a neon indicator tube which will light up with a bluish glow in the presence of a field density of approximately 10 mw/cm^2.

The second method utilizes a micro-ammeter and a dipole antenna in conjunction with a crystal detector.

DESCRIPTION OF CIRCUITS

I. Neon Indicator Tube Device

This device utilizes a neon indicator tube Amperex Type No. 4662. When this tube is pre-ignited, main discharge will occur when the tube enters an RF field density of approximately 10 mw/cm^2. During this discharge, the tube glows a bluish color.

Figure 1A shows the circuit used to pre-ignite the tube. This circuit is essentially a voltage doubling circuit. The values of capacitance shown in the schematic were chosen to provide sufficient voltage from the doubler circuit to pre-ignite the tube.

The small size of the components used allows the circuit to be built into a handle which serves to hold the tube (Fig. 1B). Care must be taken to shield the circuit, leads, and pins of the tube. This must be done to insure that main discharge takes place when the tube enters an RF field of sufficient density and not through pick-up in the wiring. Effective shielding is achieved if the handle used to enclose the circuit is metallic, even though the metallic handle will disturb the RF field. The use of a metallic handle requires careful insulation of the circuitry and leads as the voltages encountered could be hazardous to the user. A further precaution to prevent this shock hazard is to ground the handle by using a three-prong plug.

ALR #1092 August, 1967

II. Meter-Detector Device

This device is a very simple field strength meter consisting of a micro-ammeter, dipole antenna, and a crystal detector. The schematic diagram in Figure 2 illustrates the circuitry involved. A type IN25 crystal diode was chosen for its burn out characteristics. A type IN21 crystal may be substituted if more sensitivity is required.

A potentiometer is used to shunt the input to the meter and allow adjustment and calibration of the RF field detector.

Calibration of the field detector is accomplished by using a variable source of RF radiation capable of producing a field density of 10 mw/cm^2. The detector to be calibrated is then compared to an instrument of known accuracy (such as a Ramcor Model 1200 Densiometer). The potentiometer is then adjusted to produce a mid-scale reading in the presence of a 10 mw/cm^2 RF field. Further calibration may be made at 5 and 15 mw/cm^2 levels if it is desired.

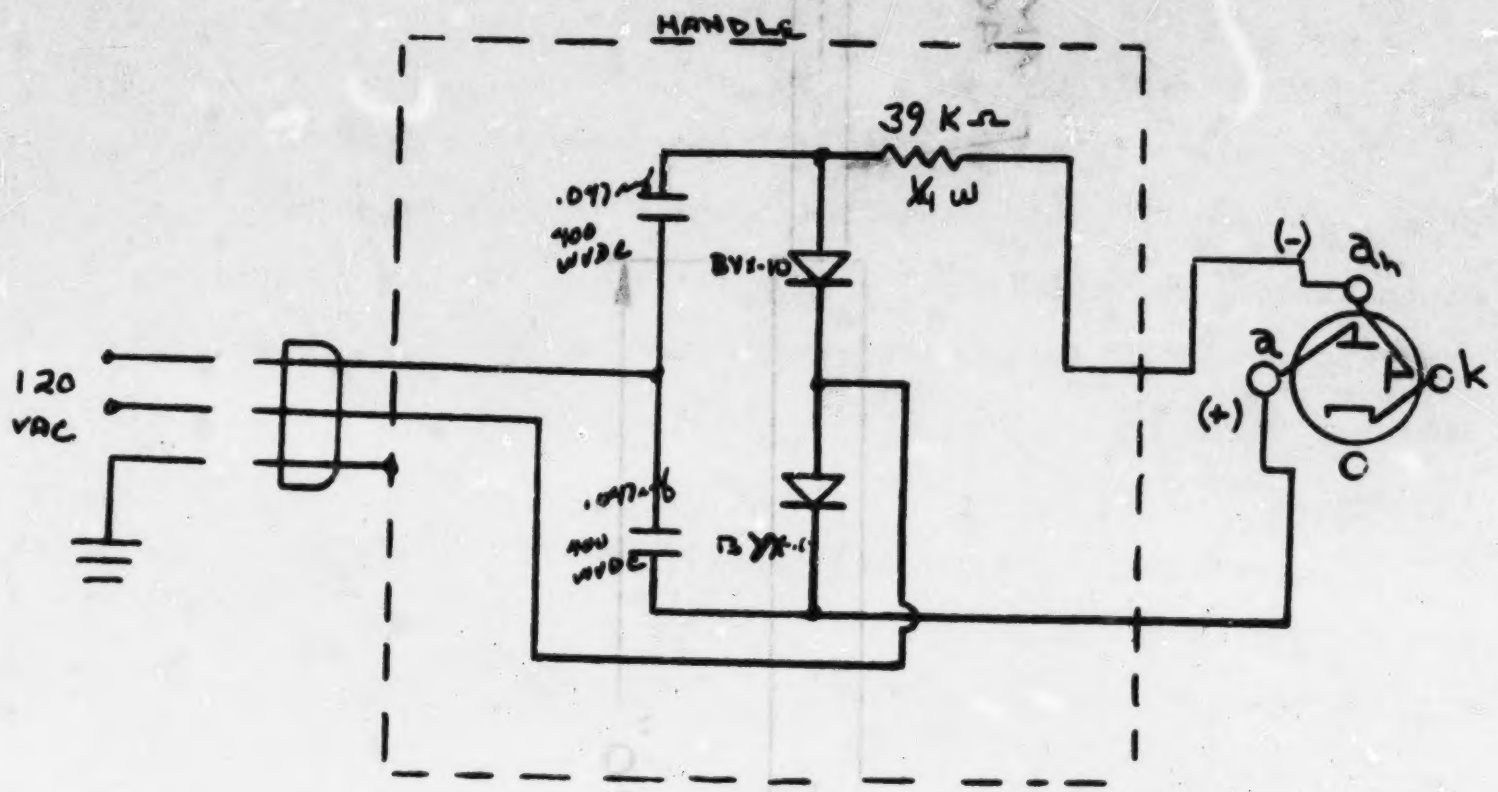
Drawings numbered S-32125-12A, S-32126-12, S-32127-2, S-32128-1, and S-32129-1 showing details of construction are available upon request. Reduced copies of assembly drawings S-32125-12A and S-32126-12A may be found in Figures 3A and 3B.

Authors: Richard Kaminsky
R. Kaminsky

Raymond B Rathmann
R. Rathmann

RK/RR/WH/gf
Code 2

Approved: W. C. Hickman
W. Hickman, Section Head
Microwave Applications Dept.


HANDLE
39 K Ω
½ W
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400 WVDC
BY 1-10
120 VAC
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400 WVDC
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ok

fig 1A

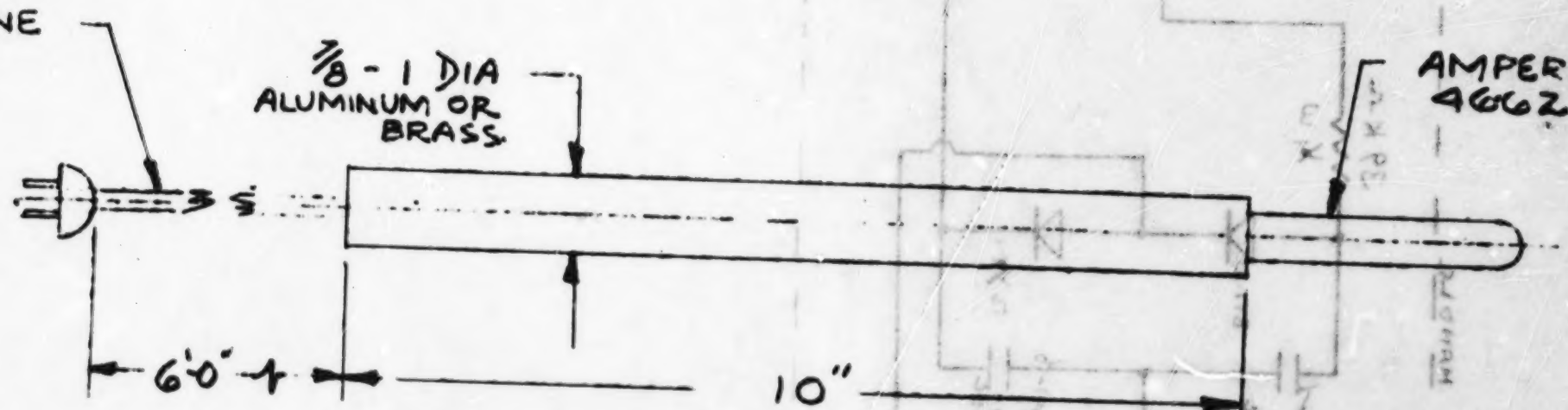

FIG. 1B

APPENDIX C

CORRESPONDENCE

INTERNATIONAL CRYSTAL MANUFACTURING CO., INC.
10 NORTH LEE • OKLAHOMA CITY, OKLAHOMA
TELEPHONE 405-236-3741 • TELEX 071-347 • TWX 910-831-3177 • CABLE INCRYSTAL

January 21, 1970

REFERENCE:

Mr. McConaghy

Mr. John C. Villforth, Director
Bureau of Radiological Health
Department of Health, Education & Welfare
Rockville, Maryland 20852

Dear Mr. Villforth:

Thank you for your letter of January 16 regarding the Microlite lamps. Please feel free to distribute your findings to all interested people.

Since talking with you at the recent meeting we have been evaluating the lamps on the basis of the proposed test. A group of 51 assemblies were tested for ignition of the tip glow. Five units started tip glow between 6 and 8 MW/CM^2; 24 units started tip glow between 8 and 10 MW/CM^2; 17 units started tip glow between 10 and 12 MW/CM^2; and the remaining five units started between 12 and 15 MW/CM^2. Tests were made using a steady slot source calibrated against the Narda 8100 at two inches. The initial glow (Level #1) with all units fell between 1/2 and 2 MW/CM^2. Lamps exposed to levels of 200 MW/CM^2 showed no noticeable change in ignition levels. Line voltage had no noticeable change in tip glow point between 80 and 130 VAC. The Level #1 or initial glow was increased approximately 1/2 MW/CM^2 at low line voltages.

I am passing this information along in the event you feel that you wish to test a larger group of lamps. In the meantime, we shall be processing additional groups and will let you know our findings.

Yours very truly,

INTERNATIONAL CRYSTAL MFG. CO., INC.

R. R. Freeland,
President

BRH RECEIVED JAN 27 1970

INTERNATIONAL CRYSTAL MANUFACTURING CO., INC.
10 NORTH LEE • OKLAHOMA CITY, OKLAHOMA
TELEPHONE 405-236-3741 • TELEX 071-347 • TWX 910-831-3177 • CABLE INCRYSTAL

REFERENCE:

January 23, 1970

Mr. John C. Villforth, Director
Bureau of Radiological Health
Department of Health, Education & Welfare
Rockville, Maryland 20852

Dear Mr. Villforth:

In connection with our further testing of the Microlite we are adding the following to our manufacturing and testing specifications.

(1) The plastic spacer will be cemented in place using 732 RTV.

(2) Each lamp will be tested using a slot source with level adjusted to 11 MW/CM^2 (plus or minus 1 MW/CM^2) at a 2 inch distance as measured by a Narda 8100. Each lamp must glow in the tip area when exposed to this field. Lamps not meeting this level will be rejected.

(3) "Certified" lamps will be further selected for ignition below 10 MW/CM^2 and the initial glow point plus the tip glow level will be noted and indicated on the lamp.

We also find that using the back side of the spacer toward the oven (opposite wedge end) we obtain tip ignition between 2 and 5 MW/CM^2. This can possibly be used to an advantage over our Level #2 point which is somewhat difficult to read.

Yours very truly,

INTERNATIONAL CRYSTAL MFG. CO., INC.

R. R. Freeland,
President

BRH RECEIVED JAN 27 1970

ADDENDUM

A copy of this report (BRH/DEP 70-20) on the Microlite 287 probe, was sent to Mr. R. R. Freeland, President of the International Crystal Manufacturing Company, on May 13, 1970, for comment. His comments follow.

INTERNATIONAL CRYSTAL MANUFACTURING CO., INC.
10 NORTH LEE • OKLAHOMA CITY, OKLAHOMA
TELEPHONE 405-236-3741 • TELEX 071-347 • TWX 910-831-3177 • CABLE INCRYSTAL

REFERENCE:

May 18, 1970

Robert L. Elder, Sc D
Acting Director
Division of Electronic Products
Bureau of Radiological Health
Rockville, Maryland 20852

Dear Dr. Elder:

Thank you for the copy of your report on the Microlite 287. I am enclosing two additional sheets of data we have added to our information file. I think of interest is the difference in readings of CW (or stirrer not rotating) of that with stirrer rotating. Our results show that the lamp when calibrated in a CW field will indicate level #3 glow in a stirrer field of peak value, which tends to place the test on the safe side.

We would be very interested in receiving the probes you number as 1 and 2, to investigate the level #3 glow in these two lamps. It is our intent in the Microlite program that the lamp be used as a go/nogo device in the level #3 area. The other levels give us some indication of the nature of the oven. Too, this device will not be satisfactory to meet the new standards and will be superceded by a detector-meter type unit.

I feel your statement, "particularly in detecting grossly excessive levels of microwave power leakage" is most accurate in connection with this instrument. We are, however, interested in assuring a maximum of 12MW/CM^2 in level #3 and thus our request to examine the numbers 1 and 2 probe.

Yours very truly,

INTERNATIONAL CRYSTAL MFG. CO., INC.

R. R. Freeland,
President

EVALUATING GLOW IN THE LEVEL 3 AREA

Lamp glow in the level 3 area indicates the power density at point exceeds 8 milliwatts per square centimeter. In order to approximate the power leakage being encountered, the lamp should be moved back from the point until the level 3 glow goes out. Move the lamp slightly to find the point of glow just starting. Using a plastic ruler determine the distance between the end of the spacer and oven surface. The table below gives an approximation of distance vs level 3 glow. Area beyond the point where level 3 glow goes out can be considered safe operating areas

Measured Distance Between End of Spacer and Oven	Approximate Density At Two Inches*
½ inch	25 mw/cm^2
1 inch	50 mw/cm^2
2 inch	100 mw/cm^2

* Density at the lamp when end of spacer is on oven surface. Data measured using a slot source and Narda 8100 meter to set reference levels.

CW VS STIRRER MODE OPERATION FOR MICROLITE 287

The Microlite 287 is checked using a CW (continuous wave) signal. The lamps must have Level #3 glow in a field of 10 mw/cm^2 as set against a Narada 8100. In practice when checking ovens in operation, the signal will vary with stirrer rotation. The Microlite 287 will continue to indicate the peak stirrer field and will flash in the 3rd level with 10 mw/cm^2 or less. The Narda 8100, however, will read somewhat less since it is an averaging device. The following table shows the difference in reading of the Narda 8100 in CW and stirrer readings as used to check three different Microlite 287 units. In both modes the power was adjusted at a point to just start level #3 glow. Stirrer speed 48 rpm.

Microlite No.	Level#3 Glow Start CW 8100 Reading	Level #3 Glow Start Stirrer Mode	
		8100 Fast	8100 Slow
1	10 mw/cm^2	5-7 mw/cm^2	6½ mw/cm^2
2	9	5-6½	6
3	8	4-5	4½

When a field was set up in the stirrer mode such that the 8100 read 10 mw/cm^2 in "slow" time constant, Microlite #1 had to be moved back from the slot source ½ inch for a glow-start point. Microlite #3 had to be moved back 5/8 inch. It can therefore be seen that the Microlite is somewhat more critical of power leakage than the 8100. The amount will vary with the speed of stirrer rotation, as this will effect the reading of the 8100. The Microlite 287 will at all times indicate the maximum power reached during the stirrer cycle.

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Herbert F. Klein, Mays L. Swicord, David G. Brown and Robert L. Moore
INVESTIGATION OF THE RESPONSE OF THE MICROLITE 287 PROBE TO MICROWAVE FIELDS
U.S. Department of Health, Education, and Welfare, Public Health Service Publication Number BRH/DEP 70-20 (August 1970), 44 pp. (limited distribution).

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probe-to-probe variability and the difficulty encountered in observing the change in glow intensity seriously limit the usefulness of the probe as a measurement device. It may be useful as a device for detecting gross microwave oven leakage.

KEY WORDS:

Microwave oven; Instrumentation; Power detector

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